Patent Application of

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for

Thin Motor and Pump

Field of Invention

The present invention relates to motors and pumps that are thin.

Previous Arts

US patent number	Inventor	Date
6210118	Egawa	4/3/01
6181050	Taussig	1/30/01
6179596	Weisener	1/30/01
5191251	Paratte	3/2/92
5189323	Carr	2/23/93
5187399	Car	2/16/93
5144183	Farrenkopf	9/1/92
5113100	Taghezout	5/12/92

5013954	Shibaike	5/7/91
4906884	Teshigawara	3/6/90
4829208	Uchino	5/9/89
4827175	Kobayashi	5/2/89
4374336	Shimizu	2/15/83
4035677	Kusayama	7/12/77
4012899	Matsuura	3/22/77

Background

All conventional electromagnetic motors, including rotational, linear, and flat motors, have cylinder type. All conventional pumps designed based on these motors are thick. The equipment, especially the medical devices, designed based on these pumps are thick, too. Some patients, like the type 1 diabetes, need medication constantly. The infusion pumps are good for them. However, the infusion pumps in the market are made of the conventional motors and, hence, are thick. They are not convenient to carry.

Micro motors based on silicone can be thin but have small power. The piezoelectronic micropumps are thin. However, the technique is not stable, yet, the volume is usually small, and the pressure of the outlet is usually small.

The present invention uses the matured electromagnetic technique to design thin motors and pumps. It is composed of arbitrary number of, may be many, elemental motors or the like. Each elemental motor or the like is as thin as desired. The power of all elemental motors or the like is integrated so that the actuator of the overall apparatus is as thin as an elemental motor or the like and has desired power. The infusion pump using the thin motor can be thin. So, the patients can conveniently put the medication infusion pumps under their clothes.

Objects and Advantages

My present invention presents conceptual models of thin motors. The pumps and other equipment that are based on these apparatuses can be thin and, hence, are more convenient to carry. For example, the medication infusion pumps can be put under the clothes.

Drawing Figures:

Fig. 1: The conceptual structure of the thin motor having 8 linear motors.

Fig. 2: The enlarged actuator in Fig. 1.

Fig. 3: The position detector of the thin motor in Fig. 1.

Fig. 4: The timing diagram when linear motors in Fig. 1 change the current polarity.

Fig. 5: The conceptual structure of the thin motor having 6 coils reacting with 6 magnet rods or coils, respectively.

Fig. 6: The enlarged actuator in Fig. 5.

Fig. 7: The position detector of the thin motor in Fig. 5.

Fig. 8: The timing diagram when coils in Fig. 5 change the current polarity.

Fig. 9: The conceptual structure of the thin motor having 6 coils pulling 6 iron bars, respectively.

Fig. 10: The thin motors using flat motors as elemental motors.

Fig. 11: The thin motors using rotational motors as elemental motors.

Fig. 12: The conceptual structure of thin pump based on the flat motors.

Fig. 13: The inner bottom view of thin reservoir.

Fig. 14: The conceptual structure of thin pump based on the small rotational motors.

Reference Numerals in Drawings:

10A to 10I: The coils or the elemental motors.

10X: Anyone of 10A to 10I.

20A to 20I: The magnet rods, coils, or the iron bars that react with the fields generated by 10A to 10I, respectively, to drive the actuator 50.

20X: Anyone of 20A to 20I.

30A to 30I: The coupling devices to transfer the movement of 20A to 20I, respectively, to the actuator 50.

30X: Anyone of 30A to 30I.

40A to 40I: The moveable joints to connect 30A to 30I and 20A to 20I, respectively.

40X: Anyone of 40A to 40I.

50: The actuator that drives the loads.

60: The position detector.

70: The load.

80A to 80F: The fixed joints of 30A to 30F, respectively, if there is.

80X: Anyone of 80A to 80F.

90A to 90F: The moveable joints of 30A to 30F, respectively, if there is.

90X: Anyone of 90A to 90F.

100: The reservoir.

110: The plunger of the reservoir.

120: The piston of the reservoir.

130 and 140: The inlet and the outlet valves, respectively.

Summary

A number of elemental motors or the like are installed on a surface. Their movement is transferred to the actuator to drive the load. The elemental motors or the like can be as thin as desired. The number of the elemental motors or the like can be large to have desired power. Hence, the invented motor can be as thin as the elemental motors or the like. Installing a thin or small reservoir on the same surface to have the actuator drive the plunger of the reservoir, the pump is thin and can deliver desired amount of liquid at desired moments of time. For medical application, the output medication is delivered into the user's body.

Description

Fig. 1 shows the conceptual structure of a thin motor having 8 small linear motors that are arranged on a surface. So, the overall apparatus is as thin as the small linear motor. The linear motors have moveable magnet rods ***20A, 20B, 20C, 20D, 20E, 20F, 20G,*** and ***20H*** in the corresponding coils ***10A, 10B, 10C, 10D, 10E, 10F, 10G,*** and ***10H,*** respectively. When current is applied to the coil ***10X***, the generated electromagnetic field is either in the same or in the opposite direction with the magnetic field of the magnet rod ***20X***. Therefore, controlling the direction of the current in the coil ***10X*** will drive the magnet rod ***20X*** to move back and forth.

Each magnet rod ***20X*** is connected to its coupling device ***30X*** with the moveable joint ***40X***. Each coupling device ***30X*** is connected to the actuator ***50***. Fig. 2 shows the

enlarged actuator ***50***. So, the magnet rods ***20A*** to ***20H*** drive the actuator ***50*** to rotate. The actuator ***50*** then drives the load ***70*** to rotate.

Fig. 4 shows the timing diagram of when to change the polarity of the current in each coil to make the actuator ***50*** rotate counterclockwise assuming that positive polarity will make the magnet rod pull the actuator. As the figure shows, each coil ***10X*** changes polarity when the corresponding part of the actuator ***50*** is at the nearest and at the farthest positions to make the actuator ***50*** continue to rotate. To rotate clockwise, the current in each coil ***10X*** changes the polarity at the same position but with reverse polarity as counterclockwise rotating.

The position detector ***60*** detects the position of the actuator ***50***. Any device that can detect the position of the actuator ***50*** will work. Fig. 3 shows a simple position detector ***60***. The position detector ***60*** is divided into 8 fans. The controller can detect the position of the actuator ***50*** by detecting which fan touches the actuator ***50***.

Since the position detector ***60*** detects the position of the actuator ***50***, the controller may apply current to all coils ***10A, 10B, 10C, 10D, 10E, 10F, 10G,*** and ***10H*** from t_x to t_y according to the timing diagram in Fig. 4. In the other words, the controller can control the load ***70*** to rotate any number of 1/8 turns in any direction at any time. This feature can be used to deliver exact amount of medication to the patient.

Note that the number of linear motors is arbitrary; and that the position detector ***60*** can be divided into *n* fans so that the load ***70*** can rotate any number of *1/n* turns. An alternative is that each magnet rod ***20X*** is replaced with a coil.

The thickness of the invented thin motor is determined by the diameter of the linear motors, the actuator, and the coupling devices. To make very thin motor, the linear

motors are made as thin as possible. Then, the number of linear motors may be large to have the desired power.

If the motor is required to be very thin, the linear motors may be too thin to be made. Fig. 5 shows an alternative way to make it. It scarifies the efficiency to trade for thinness. In Fig. 5, there are 6 coils ***10A, 10B, 10C, 10D, 10E,*** and ***10F***. The magnet rods ***20A, 20B, 20C, 20D, 20E,*** and ***20F*** are moved out of the coils. Each magnet rod ***20X*** is close to the coil ***10X***. When current is applied to the coil ***10X***, the generated magnetic field will push or pull the magnet rod ***20X***. The magnet rod ***20X*** is connected to the coupling device ***30X*** via a moveable joint ***40X*** as above. Each coupling device ***30X*** is connected to the actuator ***50***. Because of the orientation, each coupling device ***30X*** has a fixed joint ***80X*** and a moveable joint ***90X***. So, when the magnet rod ***20X*** is pushed or pulled by the coil ***10X***, the actuator ***50*** is driven to rotate. Fig. 6 shows the actuator ***50***. Fig. 7 shows a simple position detector ***60*** that is divided into 6 fans and the controller can detect which fan touches the actuator ***50***. Fig. 8 shows the timing diagram of when to change the current to the coils to make the actuator ***50*** rotate counterclockwise. To make the actuator ***50*** rotate clockwise the polarities are reversed.

Note that the number of magnet rod ***20X*** and coil ***10X*** pairs is arbitrary and that the position detector ***60*** can be divided into *n* fans so that the load ***70*** can rotate any number of *1/n* turns. Alternatives include that each magnet rod ***20X*** is fixed and the coil ***10X*** is moveable; that each magnet rod ***20X*** is replaced with a coil; and both.

The efficiency of this kind of design is smaller than that of the previous one. However, since the magnet rods are removed from the coils, the coils can be significantly

thinner than that of the previous design. Hence, the motor can be thinner than the previous one.

Another alternative is that the magnet rod is replaced by an iron bar as shown in Fig. 9. Then, the coil ***10X*** can only pull but cannot push the iron bar ***20X***. The efficiency is even poorer but the motor is easier to make.

Fig. 10 shows the thin motor having 9 flat motors ***10A*** to ***10I*** as the elemental motors. The rotators ***20A*** to ***20I*** are linked by a belt or a chain ***30A*** to the actuator ***50***. The actuator ***50*** has a gear ***50A*** that drives the load ***70***. The position detector ***60*** determines the position of the actuator ***50*** so that the controller can determine how to supply each flat motors ***10X*** electrical current.

Fig. 11 shows the thin motor having 8 rotational motors ***10A*** to ***10H*** as the elemental motors. Each rotator ***20X*** of the rotational motor ***10X*** has a coupling gear ***30X***. The actuator ***50*** is a gear, too. The coupling gears ***30A*** to ***30H*** and the actuator ***50*** are in gear so that the 8 rotational motors ***10A*** to ***10H*** drives the actuator ***50*** that drives the load ***70***. The position detector ***60*** determines the position of the actuator ***50*** so that the controller can determine how to supply each rotational motors ***10X*** electrical current.

Coupling a fine or thin reservoir ***100*** to a thin motor, two thin pumps are shown in Figs 12 and 14 where the load ***70*** is a male screw that drives the plunger, a female screw, ***110***. The plunger ***110*** drives the piston ***120*** to move up and down. The inlet valve ***130*** and the outlet valve ***140*** will control the fluid to be drawn in and pressed out of the reservoir. Fig. 13 shows the inner bottom view of a thin reservoir.

Conclusion

Accordingly, the readers will see that the thin motor disclosed in this invention can be very thin and can drive the actuator to move. Coupling with a thin or small reservoir, the apparatus can draw fluid, including medication, into the reservoir and press the fluid out of the reservoir. For medical application, the output medication is delivered into the user's body. The amount of output liquid can be controlled to be very fine. Comparing to the conventional motor and pumps, the apparatus using my invention can be very thin. It can be put under the user's closes and, hence, is much more convenient to be carried by the users.

Although the description above contains many specifications, these should not be constructed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.